# HISTORIC AMERICAN ENGINEERING RECORD
# ADDENDUM

FULL SCALE (30 x 60-FOOT) TUNNEL
BUILDING 643

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA

**Submitted to:**
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LANGLEY RESEARCH CENTER

**Submitted by:**
JAMES RIVER INSTITUTE FOR ARCHAEOLOGY, INC.

**Date: September 2006**

**HISTORIC AMERICAN ENGINEERING RECORD**
**ADDENDUM**

**NASA LANGLEY RESEARCH CENTER**
**FULL SCALE (30 x 60-FOOT) TUNNEL**

**HAER No. VA-118-A**

**Location:** 224 Hunting Avenue
East Area of the National Aeronautics and Space Administration's (NASA) Langley Research Center (LaRC), Hampton, Virginia

UTM Coordinates: see original submission

The Full Scale Tunnel (FST), Facility No. 643, is adjacent to the southern branch of the Back River and is sited between Hormel Avenue and the river. Its front entrance faces south and its longitudinal axis is parallel with the river. Immediately to the south are the Eight Foot High Speed Wind Tunnel and the Eight Foot Transonic Pressure Tunnel. To the north are several structures including two wind tunnels, the 20-Foot Vertical Spin Tunnel (Facility No. 645, built in 1941) and the 12-Foot Low-Speed Tunnel (Facility No. 644, built in 1939). To the west is Hunting Avenue. The large-scale of these wind tunnels characterizes the setting of this part of the East Area. The administrative core of Langley Air Force Base (LAFB) surrounds the LaRC East Area and features buildings of the Renaissance Revival style. Many of these buildings have architectural and historical significance and contribute to the proposed Langley Field Historic District that is potentially eligible for listing in the National Register of Historic Places. The FST is expected to fall within the boundaries of the proposed historic district.

**Date(s) of Construction:** 1929-1931

**Engineer:** Smith J. DeFrance, Abraham Silverstein, Clinton Dearborn, and Harry J. Goett

**Present Owner(s):** United States Government

**Present Use:** Leased by Old Dominion University for graduate student research facilities

**Significance:** The FST has national significance for its role in testing high speed aircraft performance. The facility was designated a National Historic Landmark in 1985.

**Project Information:** This documentation was prepared in February 2006, for NASA Langley Research Center under contract with Science Applications International Corporation which assists NASA in addressing environmental compliance requirements.

The document was prepared as an addendum to Level III HAER documentation completed by the National Park Service. The purpose of the addendum is to provide Level I HAER documentation in partial fulfillment of the requirements of a Programmatic Agreement among the National Aeronautics and Space Administration, the National Conference of State Historic Preservation Officers, and the Advisory Council on Historic Preservation.

The documentation was prepared with the assistance of a number of individuals including:

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Special thanks are also given to Kristen Poultney and Caroline Diehl of Science Applications International Corporation and Carol Herbert of NASA for their assistance and support in completion of this project.

## CONTENTS

**Historical Background[1]:**

By the late 1920s, the first National Advisory Committee for Aeronautics (NACA) wind tunnel complex at Langley was regarded as one of the best test facilities in the world. Nonetheless, its relatively small tunnels had limitations that created a number of testing deficiencies. Aeronautical engineers had to contend with "scale effects," as the flight characteristics of a scaled-down model could not be applied to a full-sized aircraft without applying a correction factor. Scale effects could be addressed by proportionally varying air pressure in the tunnel, and the Variable Density Tunnel (VDT), completed in 1922, was the first to use the principle of variable density in pressure to accurately predict flow characteristics of scale model aircraft. The VDT was successfully used to test aircraft components, particularly airfoil sections and streamlined bodies. However, the it could not evaluate the aerodynamic characteristics of a complete airplane, including how rotating propellers affected aircraft control, nor could it adequately quantify the interference effects—or "drag penalties"—of various aircraft components such as external struts, wheels, and engine-cooling installations. In addition, aircraft test models had to withstand large forces and the strength of available materials limited their size. It was always possible to test actual aircraft in flight, but variations in atmospheric conditions required numerous flight checks to average the results. Given the current state of testing technology, the only viable alternative was to build a wind tunnel large enough to accommodate full-sized aircraft.

The first wind tunnel at Langley to accommodate full-scale aircraft components was the Propeller Research Tunnel (PRT), which became operational in 1927. Measuring 20 feet in diameter, the tunnel was large enough to test actual fuselages, engines, and propellers. Based on research conducted with the PRT, NACA engineers redesigned engine cowlings that dramatically reduced drag.

Since the PRT had amply demonstrated the potential of full-scale testing, NACA decided to build a larger tunnel to test entire aircraft, and authorized the construction of the Full Scale Tunnel (FST) at Langley in February 1929. Smith J. DeFrance led the design team, which also included Abraham Silverstein, Clinton H. Dearborn, and Harry J. Goett. The timing of the project was fortunate: the initial appropriation of $900,000 was made before the onset of the Depression; and by the time work began in the spring of 1930, labor and material costs had fallen, and the project directors could draw from a large pool of unemployed engineers.

[1] For a more detailed historical study of the Full-Scale Wind Tunnel, see: Historic American Engineering Record (HAER). NASA Langley Research Center, Full-Scale Wind Tunnel, VA-118-A. Washington, D.C.: National Park Service, U.S. Department of the Interior, 1995.

Work on the FST proceeded rapidly, and it was completed and ready for operation in May 1931, when it hosted the Sixth Annual Aircraft Engineering Conference. The largest wind tunnel in the world at that time, the FST had a distinctive design, with the building's steel framework visible on the exterior of the building. The enormous facility measured 434 feet long, 222 feet wide, and 90 feet high, and immediately became a recognizable landmark at Langley. The test section measured 30 feet high by 60 feet wide, and allowed the installation of aircraft with wingspans up to 40 feet. The tunnel was powered by two propellers, each driven by a 4,000-horsepower electric motor, which could circulate air through the test section at speeds between 25 and 118 mph. The air circuit was of the double-return type, in which the airflow from the test section was split right and left into two streams, doubling back between the test section and the building's walls, and reuniting at a settling chamber before entering the throat of the test section.

Early testing in the FST indicated unexpectedly high performance penalties from external aircraft components, such as air intakes, antennae, and canopies, prompting the government to send a steady stream of military aircraft to Langley for "drag cleanup tests." But the true value of the FST was realized when the U.S. entered World War II. The FST operated around the clock, seven days a week during the war years. Virtually every high-performance fighter aircraft was evaluated in the FST, allowing for countless design improvements that gave American pilots a critical edge in combat. A variety of other objects also were tested in the FST during its operational lifetime, including dirigibles, submarines, radar antennae, gliding parachutes, inflatable airplanes, free-flying models, and even another wind tunnel complex.

Although the performance of jet aircraft in the postwar period outpaced the relatively low speed capabilities of the FST, the facility remained an important test facility for NACA and its successor, the National Aeronautics and Space Administration (NASA). Upgrades in 1977 and 1984 improved the operation of the drive motors, and allowed the facility to continue testing aircraft whose technology and performance could not have been envisioned in the biplane era in which it was built. The wing shapes and airfoil sections of transonic and supersonic airplanes, which often exhibited poor low-speed characteristics, were effectively tested in the FST. Free-flight testing of models was also conducted, allowing engineers to identify weak design characteristics in the early stages of development. Numerous modern aircraft were tested in the FST, including the Harrier Vertical Takeoff and Landing (VTOL) fighter, the F-16 Fighting Falcon, the American supersonic transport, the X-29A forward-swept-wing experimental fighter, the Lunar Landing Test Vehicle, and the Space Shuttle.

The historical significance of the FST and its many contributions to aerospace technology were recognized when it was designated a National Historic Landmark in 1985. The oldest operating wind tunnel at Langley when NASA finally decommissioned it in October 1995, the facility gained a new lease on life when it was transferred to Old

Dominion University (ODU) under the terms of an innovative privatization program. ODU began operations at the FST in October 1996, providing engineering research

facilities for graduate students and private customers in the field of aircraft and automotive transportation. The current operating agreement with ODU expires in 2007, and at present there are no plans to extend the agreement.

**Chronology:**

| | |
|---|---|
| 1929 | NACA authorizes construction of a full-scale wind tunnel. |
| 1930 | FST operated for the first time during the 6th Annual Aircraft Engineering Conference. |
| 1938-40 | Testing of 19 different military prototypes occurs at FST with objective of improving aircraft performance. |
| 1977 | FST returns to service after complete rehabilitation. |
| 1984 | FST fans and motors are rehabilitated. |
| 1985 | FST designated National Historic Landmark. |
| 1995 | FST transferred to ODU under terms of innovative privatization program. |

**Sources Consulted:**

Baals, Donald D. and William R. Corliss. *Wind Tunnels of NASA*. Washington, D.C.: National Aeronautics and Space Administration, 1981.

Butowsky, Harry A. *Man in Space: National Historic Landmark Theme Study*. Washington, D.C.: National Park Service, Department of the Interior, 1984.

Butowsky, Harry A. National Register of Historic Places Inventory-Nomination Form, Full Scale Tunnel. Washington, D.C.: National Park Service, Department of the Interior, 1984.

Historic American Engineering Record (HAER). NASA Langley Research Center, Full-Scale Wind Tunnel, VA-118-A. Washington, D.C.: National Park Service, U.S. Department of the Interior, 1995.

National Advisory Committee for Aeronautics (NACA). *Characteristics of Nine Research Wind Tunnels of the Langley Aeronautical Laboratory*. Washington, D.C.: NACA, 1957.

Old Dominion University. Langley Full-Scale Tunnel Website, <www.lfst.com>. Norfolk, Virginia: ODU, 2004.

**Physical Description:**

The FST is the largest structure in the immediate vicinity. Rectangular in shape, it is 434'-6' long, 227' wide and 95' tall. The building has a structural steel frame supported by a piled foundation. Vertical steel trusses that project approximately five feet from the face of the building brace the exterior columns. On the exterior wall between the ground and the eaves there are six rows of horizontal steel purlins attached to the steel columns on the exterior walls. The roof has three gabled sections whose ridges parallel the long, north-south, axis of the building; the two narrowest sections of roof are above the return passages of the tunnel on the east and west sides. The widest section of gabled roof spans between the outer two sections and is above the center portion of the building containing the entrance and exit cones and the test chamber. The exterior walls and roof are clad with corrugated asbestos cement panels. The panels on the walls are applied horizontally from the inside and attached to exposed steel supports spanning vertically between the horizontal steel purlins. A large access door is located on the west side. This door provides access to the test chamber. The access path from this door passes through the tunnel's return passage; there is a matching door leading to the test chamber in the inside wall of the return passage. Relatively small windows (3 lites tall by 5 lites wide), which provide daylight within the return passage, occur in every other column bay between the third and fourth purlins above the ground. Gutters along the eaves are served by large square metal downspouts mounted on the face of the trusses bracing the columns. A small hangar (73'–8" x 31'-2") projects to the south from the southwest corner of the building. Currently located within the hangar is a working model of the FST. The exterior of the building has been painted a light gray. There is a bronze plaque on the southwest corner memorializing the designation of this facility as a National Historic Landmark in 1985.

The narrative in the 1995 Historic American Engineering Record (HAER No. VA-118-A) for the FST includes descriptions of principal interior features excerpted from Smith J. DeFrance's report Number NACA TR-459 of March 13,1933. Addressed in the HAER report are the entrance and exit cones, the test chamber, propellers (fans), motors, guide vanes, balance, and survey equipment.

NASA discontinued operations of the FST in 1996. It is now operated by the Old Dominion University College of Engineering and Technology as a teaching and research facility. The following current facility description is copied verbatim from their web site: http://www.lfst.com/. The acronym LFST used in the copied text stands for Langley Full Scale Tunnel, the name that Old Dominion University uses for the FST.

> **The Wind Tunnel -** The tunnel test section is nominally 30-ft. high, 60-ft. wide, with a quasi-elliptical cross-section, 56-ft. long. It is a closed-circuit, three-quarter open-jet, double-return, continuous flow design which operates at atmospheric pressure. The airflow from the dual fans mounted within the

collector cone is split right and left into two equal streams, each doubling back between the test section and the building walls to the entrance cone, reuniting prior to the contraction

section upstream of the test section. The contraction section and collector cones are constructed of 2 inch wood planking, attached to a steel frame and covered on the inside with galvanized sheet metal.

**Contraction Section** - The contraction is 75-ft. in length and in this distance the cross section changes from a rectangle of 72-ft. by 110-ft. to a 30-ft. by 60-ft. quasi-elliptical section. The area reduction in the contraction is very slightly below 5:1. The shape of the section was chosen to give a constant acceleration to the air stream and to retain a 9-ft. length of nozzle for directing the flow.

**Test Section** - The plenum chamber, which surrounds the working section of the jet, is 80-ft. long, 122-ft. wide and 72 ft. high. Its size and the open-jet design make the tunnel ideal for low-speed testing of large, high drag and/or high blockage test articles.

Two 20-ft. by 40-ft. doors in the walls of the return passage are located on the west side of the test chamber to provide access. A 15,000 pound overhead crane is available for lifting automobiles, aircraft or other models into the test section. Personnel access to the test section is by stairs on the west side, or by an elevator located on the east side. The top and both sides of the jet are open while the bottom has a groundboard that extends 2-feet 5-inches above the lower lip of the nozzle. Observation of tests is normally via remotely controlled video cameras. High intensity lights can be used for photography, filming or video needs. Direct observation can be done from Room 300 which is elevated on the east side of the test section. Exhaust fans are located in the ceiling for expulsion of exhaust gases. Blow-out doors are also located in the north end of the circuit for rapid purging of the circuit.

**Fan and Drive Motors** - The tunnel is powered by two-4,000-hp wound-rotor, slip-ring induction electric motors, each driving a four-blade 35.5-ft laminated wood propeller. The motors are mounted with rotor shafts centered within the exit cone passages. Rotational speed is varied by a solid state control system. The motors and supporting structure are enclosed in fairings to minimize resistance to air flow. Motors are normally started at approximately 80-RPM and can be adjusted in increments of 1, 10, or 100, to a current maximum 210-RPM. The control panel for monitoring RPM is located in the control room, and includes a trim control to synchronize the two motors. For specialized purposes, the motor winding configuration can switched to a "low speed" range, permitting steady RPMs from around 20 to above 100.

**Control Room** - Located on the north wall of the test section, the control room contains the controls for the drive motors, survey carriage, data systems, compressed air, and full scale model support. Multiple video feeds allow the viewing of the groundboard, test vehicle and fans.

**Collector Section** - Forward of the fans and located on the center line of the tunnel is a smooth fairing which transforms the quasi-elliptic section of the single passage into two circular passages at the fans. From the fans aft, the exit cone is divided into two passages and each transforms from a 35-foot 6 1/2-inch circular section to a 46-foot square in 132-feet. The included angle between the sides of each passage is approximately 6 degrees.

**Guide Vanes** - The air is turned at the four corners of each passage by guide vanes. These vanes are of the curved-airfoil type formed by two intersecting arcs with a rounded nose. The arcs were carefully chosen to give a practically constant area through the vanes.

**The Groundboard and Turntable** - The 1/4 inch smooth steel groundboard is 42-feet 6-inches in width, 52-feet 9- inches in length and is elevated 21 feet 4 inches above the ground. Ample space is available under the groundboard for running power cables and air supply lines. Four 120V receptacles

are located on each side of the ground plane. A hydraulically-driven turntable, 28.5 feet in diameter, can be rotated 360 degrees to create sideslip on the test article. The test section groundboard is being progressively reconfigured to support the special needs of automotive aerodynamic and acoustic test applications. The current capability is detailed in sections below.

**Automotive Test Capability -** A full-scale automotive force balance, known locally as a "trapeze" balance, became operational early in 1998. The trapeze balance provides accurate measurements of total vehicle drag, plus downforce at each wheel. The vehicle is supported on four small tire contact plates, separated from the surrounding non-metric groundboard. The groundboard configuration provides a boundary layer bleed roughly 15 feet ahead of the vehicle. An active boundary layer control system is also available when required, installed just ahead of the test vehicle. For larger vehicles, the tire contact plates are connected to the external 6-component balance, as described more fully below. By this means, vehicles up to 20,000 pound deadweight can be tested, such as Class-8 tractors.

**Full Scale Model Support/Balance/Scale House -** The full scale model support, balance, and scale house are located directly below the groundboard. It contains the six component balance from which the readings are fed into the control room. The scales are capable of handling loads up to 20,000 lbs.

**Aircraft Test Capability** - Struts can be extended 14-feet above the groundboard to either hold a full size general aviation aircraft, or a sting and internal balance on a T-bar for smaller test articles. A hydraulic ram makes it possible to achieve an angle of attack range up to around 70 degrees with the T-bar. The struts can also have aerodynamic fairings installed to nearly eliminate tare-drag loads when using the external balance for measurements. A wide variety of test articles can be accommodated with this balance system.

**Instrumentation and Data Acquisition Systems**

**Data system** - Multiple PC-based data systems have been developed using LabView software. The primary system acquires data from the trapeze automotive balance, internal strain gage balances, or full-scale balance, with reduced data accessible in real-time via a Local Area Network (LAN). Secondary systems are employed for acquisition of pressure vane anemometer data.

**Pressure Measurements** - The LFST is equipped with a PSI-8400 electronically scanned pressure transducer (ESP) system. The ESP system consists of a data acquisition and calibration unit, a pressure control unit, and remote pressure-measuring modules. Currently, one 48-port module is available. By adding modules, simultaneous measurements of up to several hundred pressures are possible. The ESP modules are normally mounted in the test vehicle for best results.

**Survey Carriage** - Attached to the test section roof trusses is a 55-foot steel structural bridge and car which can be rolled across the full width, length and depth of the test chamber. Suspended below the car is a retractable survey boom, which can carry a variety of survey probes, rakes and even aircraft models.

**Angle-of-Attack Measurements** - Model angle-of-attack is measured using Kearfott or Lucas Schaevitz sensors within ± 0.05 degrees.

**Turbine Anemometers** - 6 turbine-type anemometers are available for radiator through-flow measurements.

**Computational Fluid Dynamics Facilities** - LFST offers computational calculation of whole body aerodynamics as well as partial geometries and parametric designs. Fluid flow and heat transfer computations are mainly conducted on a 64-CPU Sun HPC 10000 Sunfire Supercomputer. In addition, custom built 16-CPU Linux computer cluster extends the computational capabilities.

**Ground Vehicle Simulations** - Surface pressure and velocity flowfield and force data components (drag, lift and side force) are calculated. Wake flow analysis, computational visualization and component based drag and lift analysis are also conducted.

**The Building**

**Building** - The overall size of this facility is enormous, with the building itself being 434-feet long, 222-feet wide, and reaching a maximum height of 97-feet. It covers approximately 2 1/2-acres and encloses approximately 8,000,000-cubic feet. Within this cavernous structure are located the wind tunnel, hangar, office space, and machine shop.

**Hangar** - On the south side of the LFST is an adjoining hangar that can be used for the staging and storage of large test models, general aviation aircraft or automobiles. It has a width of 62-feet, length of 75-feet, and offers 30-feet of usable height. A 3-ton overhead crane is available.

**Offices** - Within the building are 5,000- sq. ft. dedicated to office space and a conference room which are located under the return passages on the south end of the tunnel. "Secret rooms" are available for proprietary projects.

**Machine Shop** - Also housed within the building is a 7,000-sq. ft. sheet metal and machine shop that is equipped with lathes, mills, drill presses, band saws, metal forming equipment, grinders/sanders and other related equipment.

**Other Supporting Capabilities -** Also available to support testing are compressed air and DC power sources, as well as a smoke generator for flow visualization

In addition to the features described above, support spaces include offices and toilets located along the south wall. Stock rooms, storage and shop spaces are in the mid section of the building. All of these spaces are on the ground floor and located below the overhead sloping floors of the return passages and the entrance and exit cones. The offices typically have carpeted floors, prefinished plywood paneled walls and suspended acoustical tile ceilings with fluorescent lighting. They generally have a mundane character that evokes the 1950s and 1960s. While these secondary spaces generally retain their historic footprint, there have been changes in their layout and finishes over time.

In summary, this facility retains remarkable integrity of association, location, setting, design, feeling, material and workmanship.

**HISTORIC AMERICAN ENGINEERING RECORD**
**ADDENDUM**

**INDEX TO PHOTOGRAPHS**

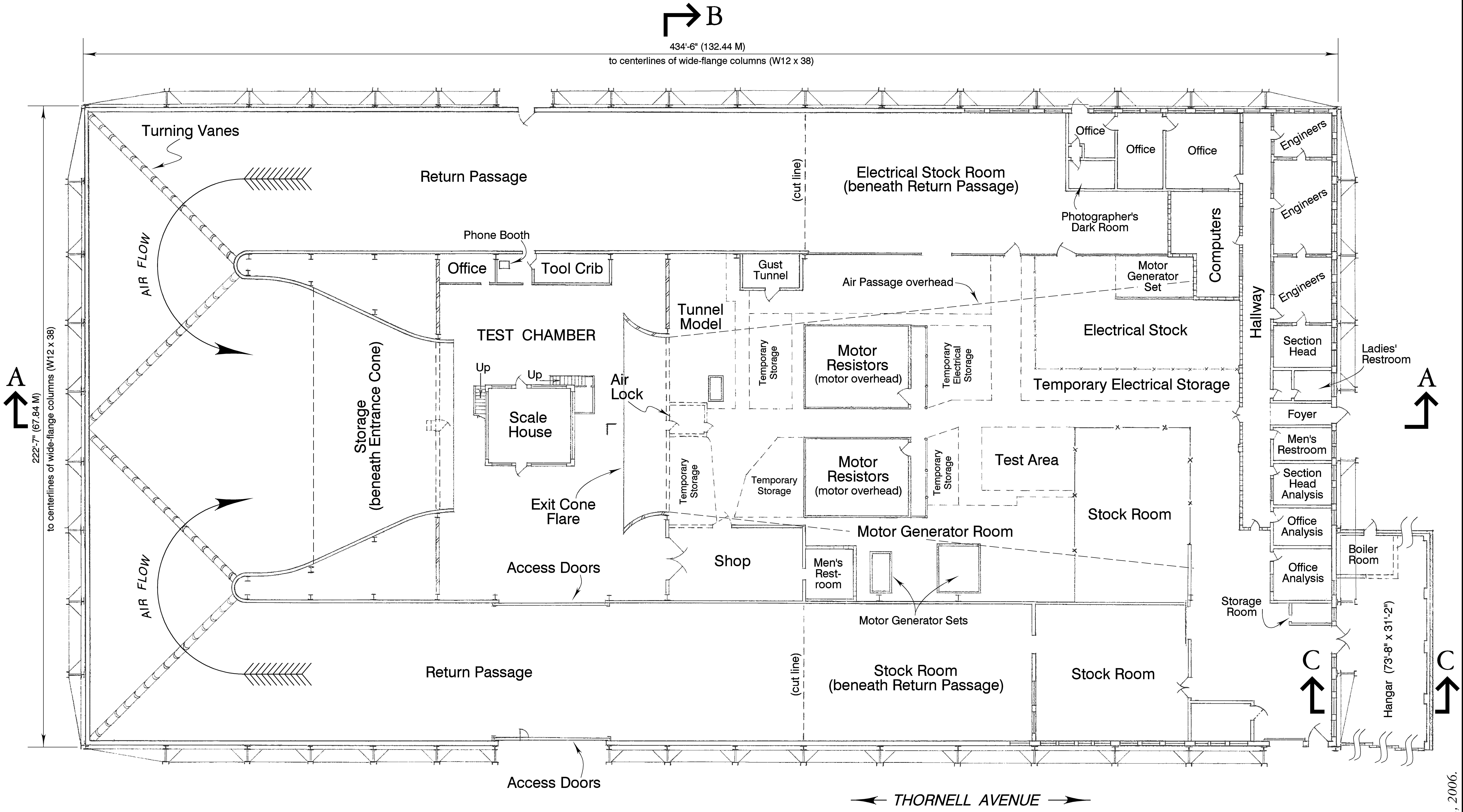
NASA LANGLEY RESEARCH CENTER HAER NO. VA-118-A
FULL SCALE (30 x 60-FOOT) TUNNEL
Hampton
Virginia

Chris Cunningham, photographer, March 2006

| | |
|---|---|
| VA-118-A-27 | Photocopy of photograph (original in Langley Research Center Archives, Hampton, Virginia [LaRC] (NACA 9203) AERIEL VIEW OF FULL SCALE TUNNEL CA. 1933. |

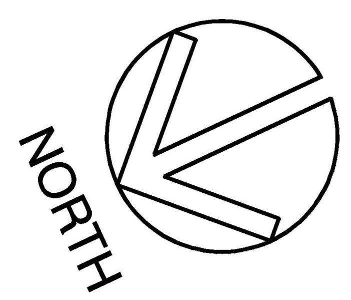
HISTORIC AMERICAN ENGINEERING RECORD ADDENDUM
SEE INDEX TO PHOTOGRAPHS FOR CAPTION

HAER NO. VA-118-A-27




# FIRST FLOOR PLAN (ca. 1942)

B




Scale: 1/16" = 1'-0" (1:192)

0 20 40 60 80 100 120 140 160 180 200 Feet

0 10 20 30 40 50 60 Meters

Based on NASA Langley Research Center drawing LD-13899, Sheet 10, January 1942. Exterior columns have been corrected for scale; original labeling was removed for clarity and larger lettering subsituted; hanger in northwest corner was foreshortened to fit drawing on this sheet. Dashed lines in shop and storage areas beneath exit cones have been retained; it was not determined whether these represented lines painted on the floor to designate usage areas, interior fences, or planned walls not yet constructed.

DELINEATED BY: *Richard K. Anderson, Jr., 2006.*

NASA LANGLEY RESEARCH CENTER RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

**ADDENDUM to FULL SCALE WIND TUNNEL (1931)**
BUILDING 643, 643 THORNELL AVENUE
HAMPTON

HAMPTON VIRGINIA

SHEET 1 OF 4

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VA-118-A

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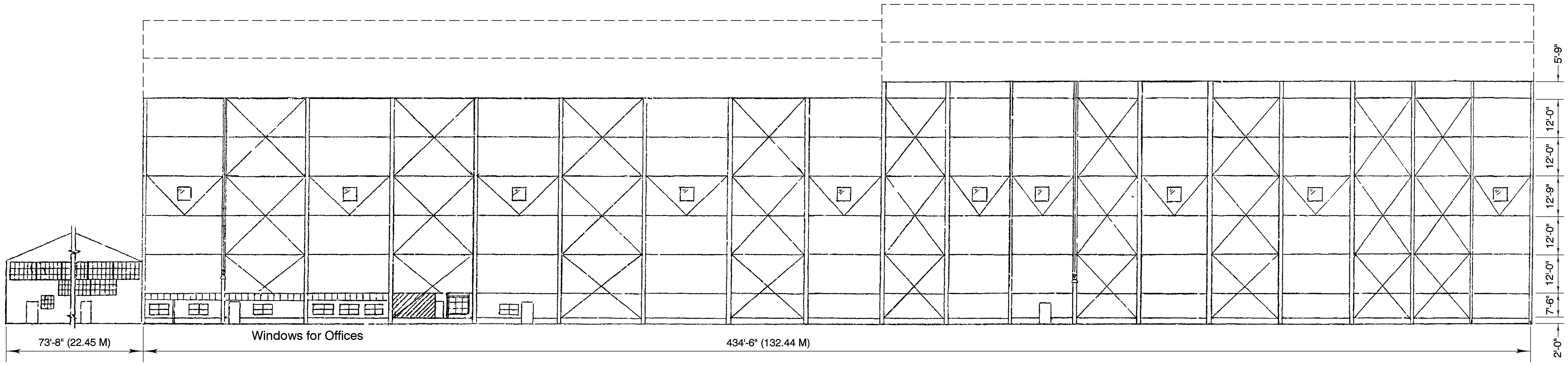
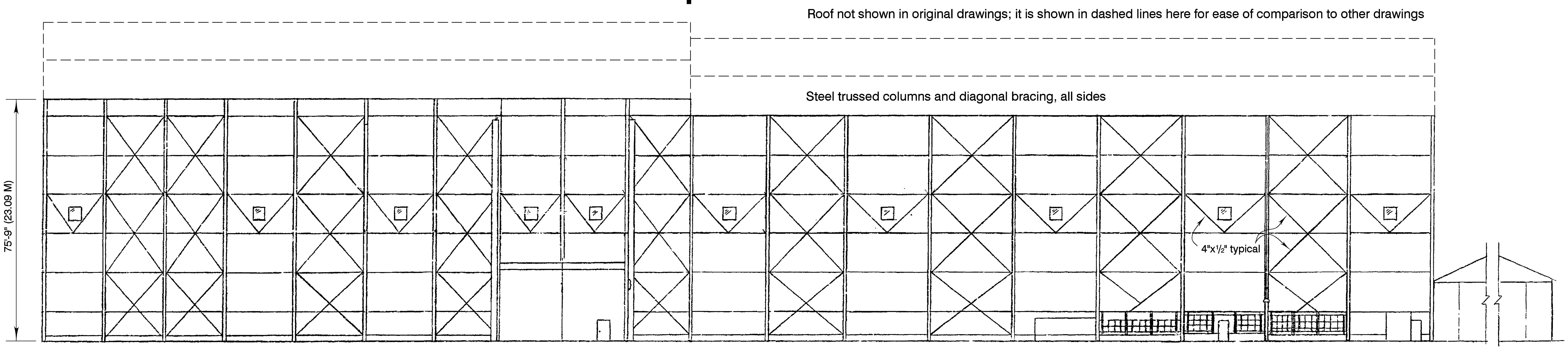
5/16" thick corrugated Careystone (cement asbestos) wall and roof panels.
Wall panels are installed with corrugations oriented horizontally, parallel with air flow.




# EAST ELEVATION
facing Southwest Branch of Back River

B




B

# WEST ELEVATION
facing Thornell Avenue

Scale: 1/16" = 1'-0" (1:192)

0 20 40 60 80 100 120 140 160 180 200 Feet
0 10 20 30 40 50 60 Meters

Based on NASA Langley Research Center drawing LD-790636 "Full Scale Tunnel Bldg. 643: East and West Elevation" by Seema, Inc., Hampton, Va. December 1987. Notes and labeling were removed for clarity.

DELINEATED BY: *Richard K. Anderson, Jr., 2006.*

NASA LANGLEY RESEARCH CENTER RECORDING PROJECT
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ADDENDUM to FULL SCALE WIND TUNNEL (1931)
BUILDING 643, 643 THORNELL AVENUE
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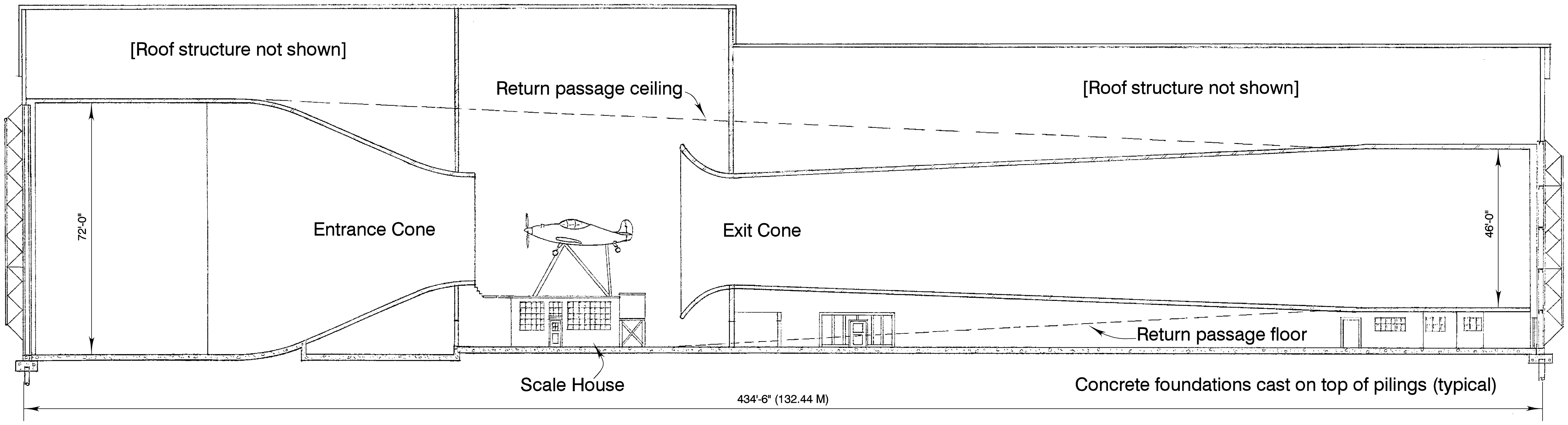


## SECTION A-A

Scale: 1/16" = 1'-0" (1:192)

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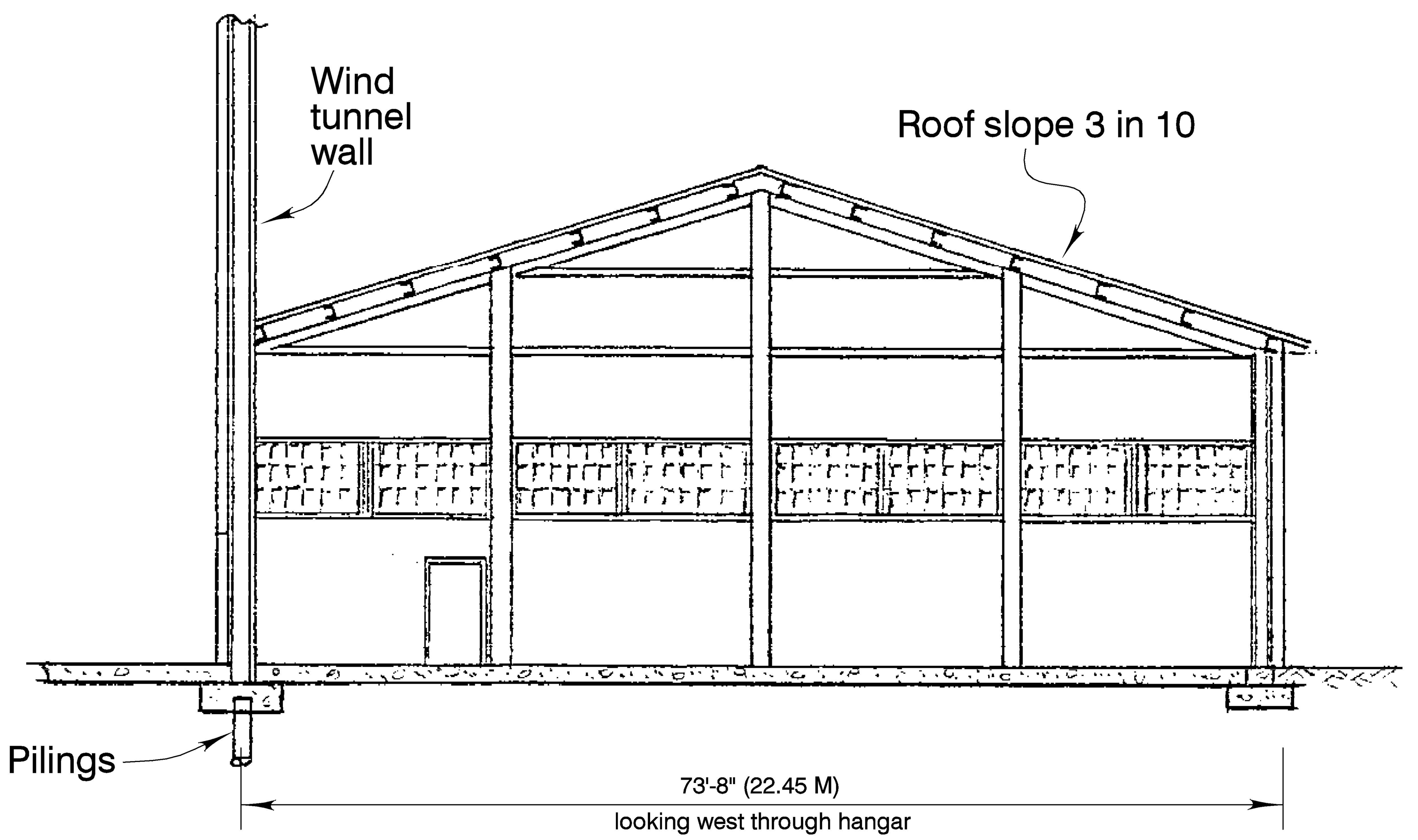
0 10 20 30 40 50 60 Meters

Based on NASA Langley Research Center drawing LD-13899, Sheet 10, June 1942.




## SECTION C-C

Scale: 1/8" = 1'-0" (1:96)

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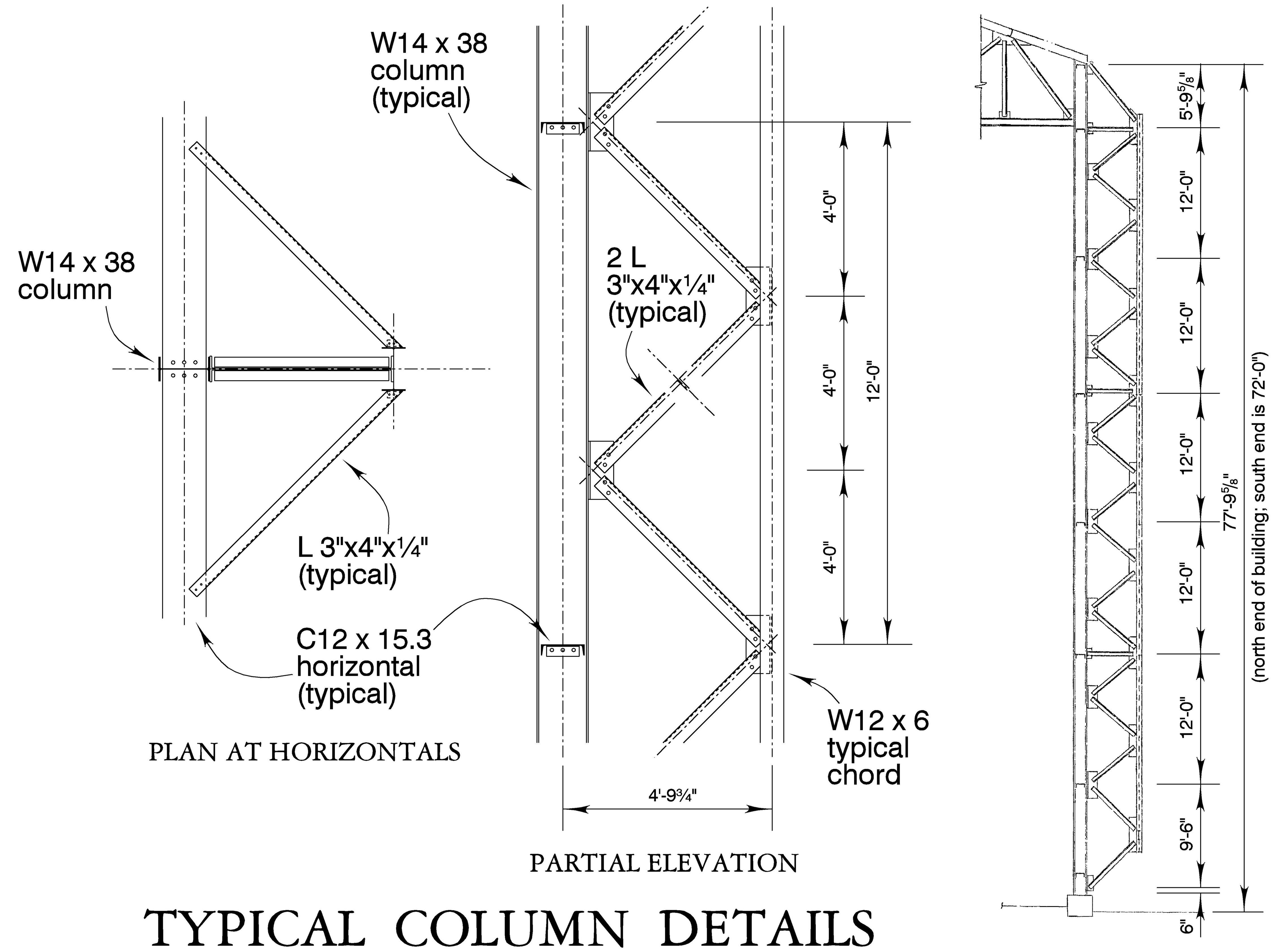
0 5 10 15 20 25 50 Meters

Based on NASA Langley Research Center drawing LD-13899, Sheet 10, June 1942.




## TYPICAL COLUMN DETAILS

Details and dimensions based on NASA Langley Research Center drawing LD-790639 by Seema, Inc., Hampton, Va., December 1982.

DELINEATED BY: Richard K. Anderson, Jr., 2006.

NASA LANGLEY RESEARCH CENTER RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

# ADDENDUM to FULL SCALE WIND TUNNEL (1931)

BUILDING 643, 643 THORNELL AVENUE
HAMPTON
HAMPTON VIRGINIA

SHEET 3 OF 4

HISTORIC AMERICAN ENGINEERING RECORD
VA-118-A

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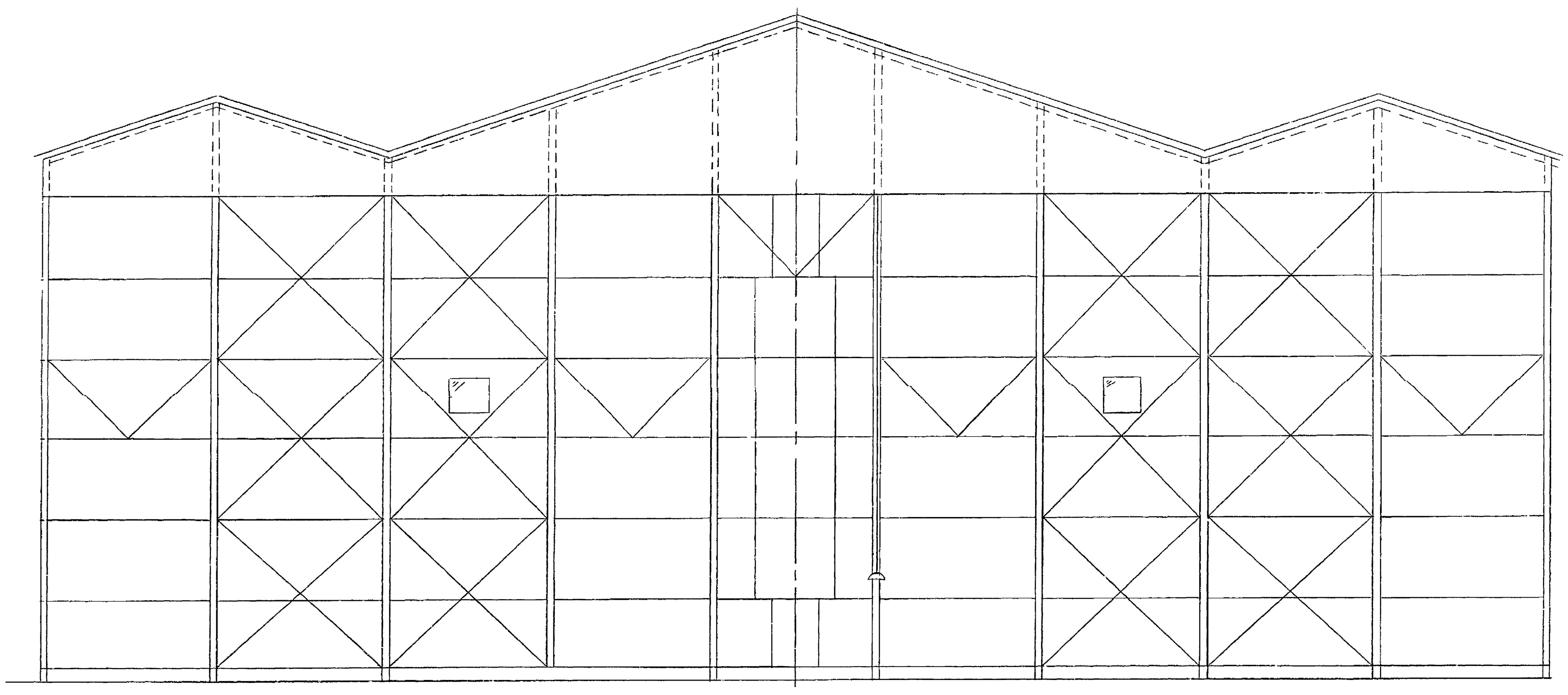
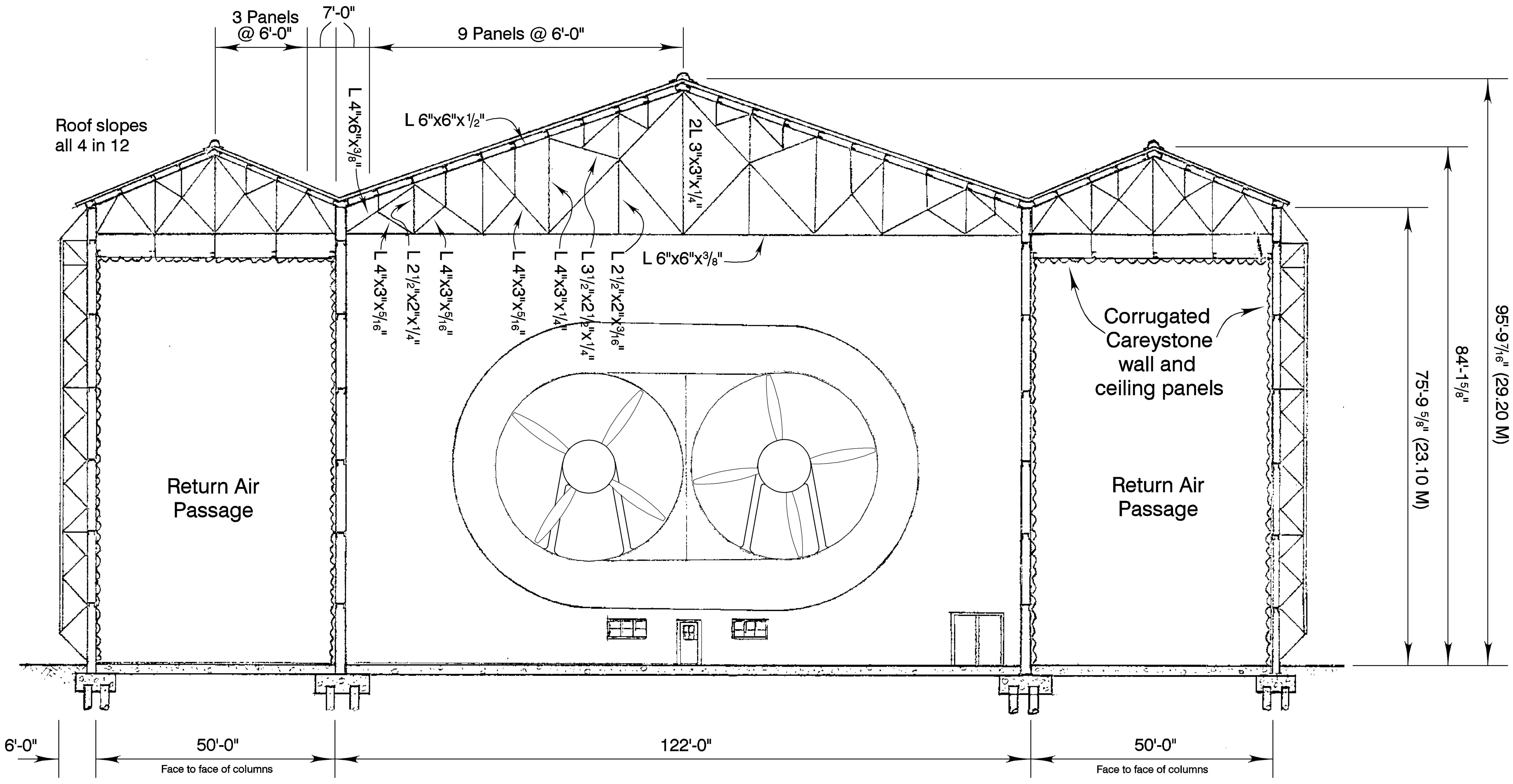
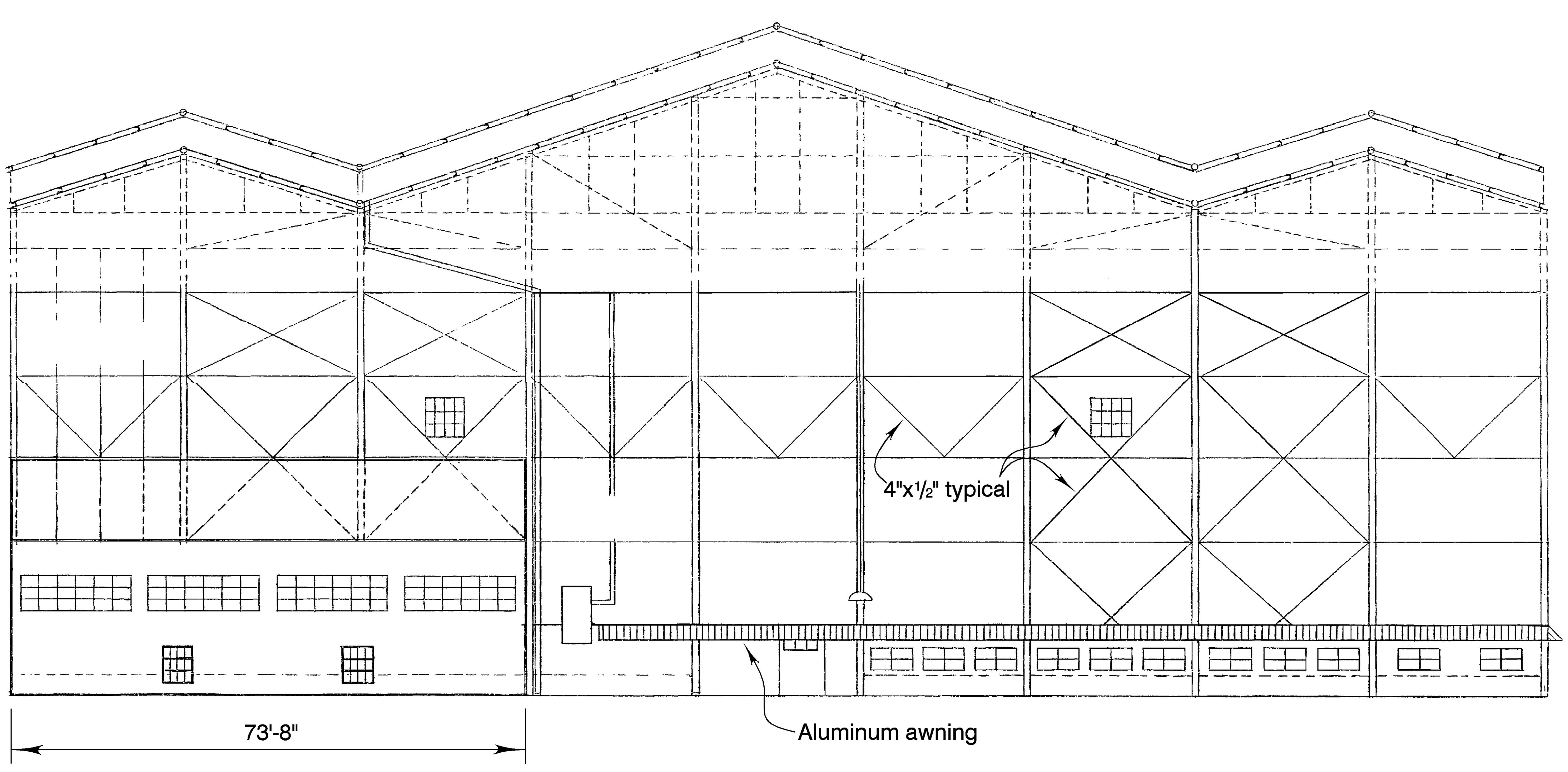


## NORTH ELEVATION




## SECTION B-B (looking south)




## SOUTH ELEVATION

Scale: 1/16" = 1'-0" (1:192)

0 20 40 60 80 100 120 140 160 180 200 Feet

0 10 20 30 40 50 60 Meters

North elevation based on NASA Langley Research Center drawing LD-790637, south elevation on drawing LD-790638, both by Seema, Inc., December 1992, Section B-B on drawing LD-13899, sheet 10, January 1942. Original labeling and dimensions were replaced to improve legibility for size. Structural steel dimensions based on drawings LD-2743, LD-6983 and LD-6984.

DELINEATED BY: *Richard K. Anderson, Jr., 2001.*

| NASA LANGLEY RESEARCH CENTER RECORDING PROJECT<br>NATIONAL PARK SERVICE<br>UNITED STATES DEPARTMENT OF THE INTERIOR | ADDENDUM to FULL SCALE WIND TUNNEL (1931)<br>BUILDING 643, 643 THORNELL AVENUE<br>HAMPTON HAMPTON VIRGINIA | SHEET<br>4 OF 4 | HISTORIC AMERICAN ENGINEERING RECORD<br>VA-118-A | LIBRARY OF CONGRESS INDEX NUMBER |
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